comprises a primary winding 3 of approximately one and a half turns and a similar secondary winding 4 of approximately one and a half turns.

The ends of the primary winding will be referred to as first and second terminals 5, 6 respectively and the ends of the secondary winding will be referred to as third and fourth terminals 7, 8 respectively. It is to be understood that this terminology does not imply a physical break in the conductors at these points.

The transformer 1 is substantially square. The primary winding 3 spirals in from the first terminal 5 and then out to the second terminal 6. The secondary winding 4 spirals in from the third terminal 7 and then out to the fourth terminal 8 in a similar manner. It should be noted that the turns of the primary and secondary windings 3, 4 are not grouped into blocks associated with either the primary or secondary winding 3, 4 only but are entwined with each other.

The spiralling of the windings 3, 4 is achieved by crossovers 9a, ... , 9f where they either cross themselves or the other winding. The paths crossing at these crossovers 9s, ... , 9f swap radial positions.

Referring particularly to Figures 1 and 2, starting at the first terminal 5, the primary winding 3 first passes over the secondary winding 4 at the first crossover 9a. The primary winding 3 then passes through one quarter turn and over itself at the second crossover 9b. A further quarter turn on, the primary winding 3 crosses over the secondary winding 4 again. The primary winding 3 has now reached the center of the transformer 1. Half a turn after reaching the center of the transformer 1, the primary winding 3 crosses under the secondary winding 4 at the fifth crossover 9e to begin spiralling out to the second terminal 6. One quarter turn after the fifth crossover 9e, the primary winding 3 passes under itself at the second crossover 9b and, one quarter turn later, the primary winding 3 passes under the secondary winding 4 at the third crossover 9c to complete its one and a half turn extent.

Referring particularly to Figures 1 and 3, starting at the third terminal 7, the secondary winding 4 first passes under the primary winding 3 at the first crossover

9a. The secondary winding 4 then passes through one quarter turn, in the opposite direction to the primary winding 3 as described above, and under itself at the fourth crossover 9d. A further quarter turn on, the secondary winding 4 crosses under the primary winding 4 again. The secondary winding 4 has now reached the center of the transformer 1. Half a turn after reaching the center of the transformer 1, the secondary winding 4 crosses over the primary winding 3 at the fifth crossover 9e to begin spiralling out to the fourth terminal 8. One quarter turn after the fifth crossover 9e, the secondary winding 4 passes over itself at the fourth crossover 9d and, one quarter turn later, the secondary winding 4 passes over the primary winding 3 at the third crossover 9c to complete its one and a half turn extent.

Referring also to Figure 5 which shows the sixth crossover 9f, the primary and secondary windings 3, 4 are each formed from tracks in three conductor (metal or polysilicon) layers 10a, 10b, 10c. SiO_2 layers (no shown) separate the conductor layers 10a, 10b, 10c. The conductors of the conductor layers 10a, 10b, 10c forming the primary winding 3 are bonded by arrays of vias 10d (see Figure 4) adjacent to the crossovers and, optionally at other locations. Similarly, the conductors of the conductor layers 10a, 10b, 10c forming the secondary winding 4 are bonded by arrays of vias 10d (see Figure 4) adjacent to the crossovers and, optionally at other locations.

The lowest conductor layer 10a forms a capacitive shield for enhancing the electrical symmetry between the primary and secondary windings 3, 4.

The middle and upper layers 10b, 10c are mirror images and provide the crossings for the secondary and primary windings 3, 4 respectively.

Referring also to Figure 6a, in the upper layer 10c, the conductors of the primary winding 3 are joined by a diagonal bridge 11 and the conductors of the secondary winding 4 are chamfered to accommodate the bridge 11 and enable them to terminate much closer to the conductors of the primary winding 3 than in the conventional arrangement as shown in Figure 6b. The conductors of the primary winding 3 are similarly chamfered in the middle layer 10b. Consequently, the length

of the bridge 11, and hence its resistance, can be smaller than in the conventional arrangement. It is important to minimise the resistance of the bridge 11 because, at the crossovers, the currents of the primary and secondary windings 3, 4 are carried in respective single conductor layers 10c, 10b.

Referring to Figure 7, the transformer 1 is underlain by a patterned ground shield 12. The ground shield 12 comprises an array of generally radially extending fingers. The fingers are connected by a broken ring 13. The broken ring 13 is positioned some distance in from the outer periphery of the ground shield 12 in a region where the transformer's magnetic field is parallel to the surface of the substrate on which the transformer 1 is formed.

Positioning the broken ring 13 in this way reduces the series resistance of the shield, when compared with a similar shield with a peripheral broken ring.

The foregoing embodiment had equal numbers of primary and secondary winding turns. However, this is not essential and the present invention can be employed in transformers having turns ratios other than 1:1. In these cases, only a portion of the turns of the winding having the larger number of turns will be entwined with those of the other winding.

Referring to Figure 8, a 2:1 turns ratio transformer has the additional turns 3a of the primary winding 3 which are encompassed by the region in which the primary and secondary windings are intermingled.

Referring to Figure 9, the additional turns 3b of the primary winding 3 of a 2:1 turns ratio transformer encompass the region in which the primary and secondary windings are intermingled.

The present invention can also be applied to transformers having more than two windings.